Mechanisms of Manganese Efficiency in Barley (*Hordeum vulgare*)

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DECLARATION

I HEREBY DECLARE that the work presented in this thesis has been carried out by myself and does not incorporate any material previously submitted for another degree in any university. To the best of my knowledge and belief, it does not contain any material previously written or published by another person, except where due reference is made in the text. I am willing to make the thesis available for photocopy and loan if it is accepted for the award of the degree.

J.L. Harbard

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DEDICATION

I wish to dedicate this work to my mother Marlene Joy Harbard in recognition of her love and support.

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ABSTRACT

This project sought to identify those mechanisms which confer Mn efficiency on some barley genotypes in the South Australian barley breeding program. Experiments were conducted under controlled environment conditions to test four areas which may contribute to Mn efficiency.

It was found that H^+ ions were extruded from roots of barley and wheat as a consequence of normal root growth and were not 'switched-on' as a consequence of Mn deficiency and these pH decreases were severely restricted in highly buffered calcareous soils of high pH. In addition, H^+ ion production was not responsible for the reduction of insoluble higher oxides of Mn as has been shown for Fe efficient dicots and some monocots. However an unidentified component of root cells was able to reduce Mn dioxide when leaked from damaged root cells of barley and wheat.

No difference between barley genotypes in seminal root morphology were identified in either soil or nutrient solution studies. However a more highly branched nodal root system was found in the more Mn efficienct genotypes which would enable greater exploration of the soil, an increase in the number of root tips which were shown to be areas of H^+ extrusion and an increased area of root exudate production.

A correlation between the severity of Mn deficiency symptoms on the plant and numbers of Mn oxidising populations in rhizosphere soil could not be established with certainty. At high soil Mn levels a decrease in numbers of colonies of Mn oxidising bacteria (not statistically significant) around the more Mn efficient cultivars was observed. This could prove to be important in increasing Mn availability to Mn efficient plants. Further studies would clarify whether this is a significant factor in determining Mn efficiency.

The critical level of Mn in whole tops was similar in Weeah and Galleon (16 and 18 µg/g respectively). However, the critical level of Mn in the young growing tissue (YEBs) as a function of YEB growth was higher in the Mn inefficient cultivar Galleon (12µg/g) than the Mn efficient cultivar Weeah (8µg/g).

Mn efficiency could not be wholly attributed to any of the mechanisms researched here. The results of this research suggests the presence of a plant produced compound released through the roots and capable of reducing unavailable Mn oxides. Further studies should therefore be directed at finding and identifying the component of root exudates in Mn efficient genotypes which can reduce insoluble Mn oxides in Mn deficient soils.

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